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MEMORANDUM REPORT NO. 1771

FIVE-INCH HARP TESTS AT BARBADOS, WEST INDIES JANUARY-FEBRUARY 1966

by

Eugene D. Boyer

July 1966

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U. S. ARMY MATERIEL COMMAND
BALLISTIC RESEARCH LABORATORIES
ABERDEEN PROVING GROUND, MARYLAND

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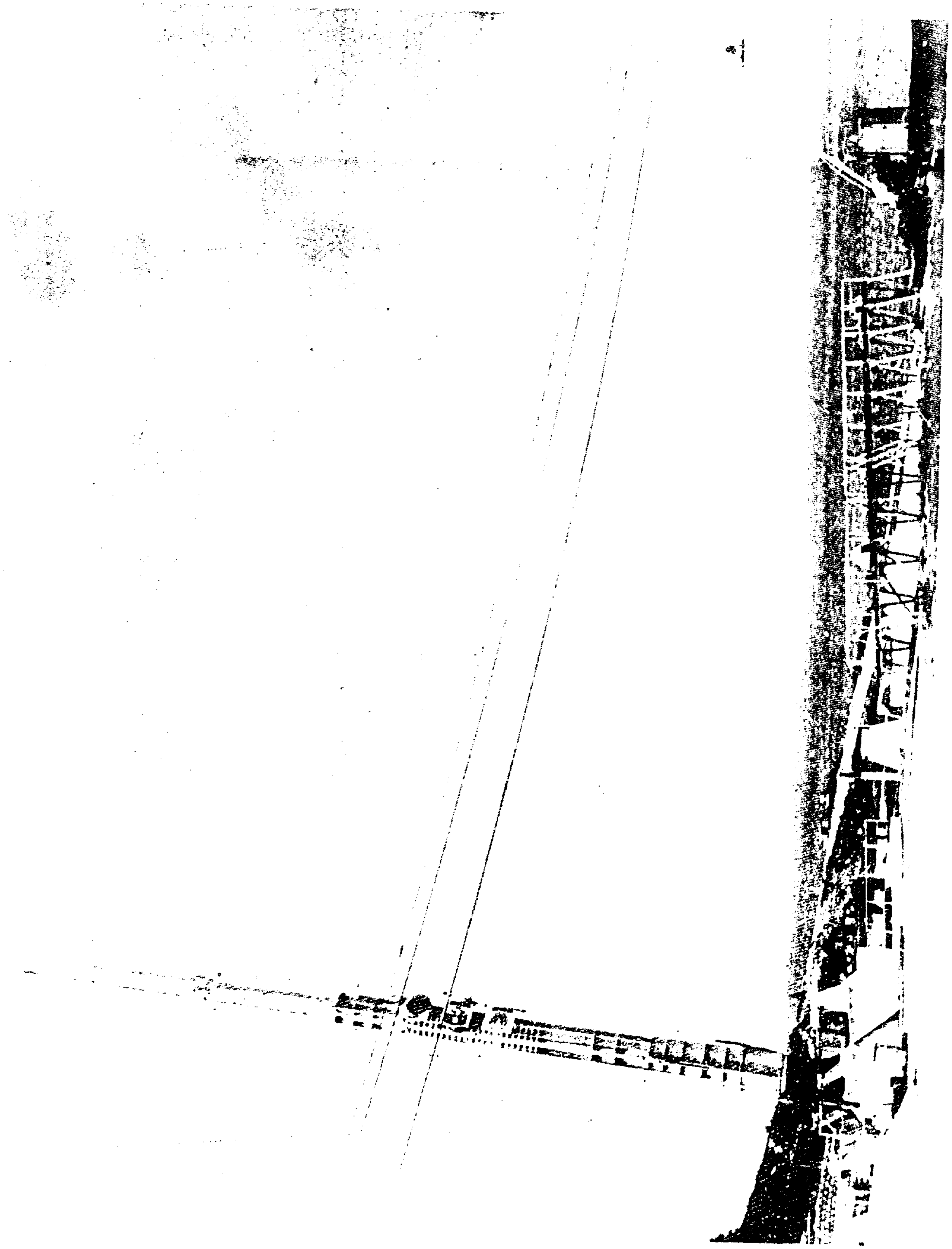
Eugene D. Boyer

Exterior Ballistics Laboratory

RDT&E Project No. 1A011001B021

ABERDEEN PROVING GROUND, MARYLAND



B A L L I S T I C   R E S E A R C H   L A B O R A T O R I E S

MEMORANDUM REPORT NO. 1771

EDBoyer/ss
Aberdeen Proving Ground, Md.
July 1966

FIVE-INCH HARP TESTS AT BARBADOS, WEST INDIES
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ABSTRACT

The installation of a 5-inch HARP gun system at Barbados, West Indies, is presented. The system is employed to carry a low cost wind sensor to 200,000 feet altitude.

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INTRODUCTION

Project HARP has been developing and utilizing gun systems to launch meteorological and upper atmospheric research probes. Presently the project utilizes three gun sizes; a fixed 16-inch system, [1,2*] a mobile 7-inch[3] system, and a relatively light mobile 5-inch[4] system. The 16-inch system is located on the Island of Barbados, West Indies, and is a joint U. S. - Canadian research project[**]. This site is normally operated by a local resident staff and is kept in a state of readiness for a one-week firing series every two months. During this firing series the staff is augmented by transient U. S. and Canadian personnel. For several reasons, the addition of smaller caliber guns to this site appeared to be most attractive:

1. We believe that the readiness of the tracking, communication, and security systems would be at a higher efficiency with firings on a weekly basis rather than once every two months.

2. More meteorological data from the general location of Barbados would be desirable since most of meteorological rocket network soundings are in the Continental United States. Rawinsonde wind data up to 100,000 feet are already being taken daily at Seawell Airport and the 16-inch system is measuring nighttime winds from 300 to 500 thousand feet several times a year. Thus, wind measurements from 100,000 feet to 300,000 feet would be most valuable. This is even more attractive, since the added cost would essentially consist of only the flight hardware at $400 per flight.

3. The installation of a second gun would permit experiments where dual-firings are desired.

These factors led to the decision to emplace a 5-inch system.

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* *Superscript numbers denote references which may be found on page 24.*

** *A second vertical fire 16-inch gun has been installed at Yuma Proving Ground, Arizona.*

PRELIMINARY PLANS

The 5-inch HARP system has been operated primarily by the Ballistic Research Laboratories (BRL) personnel. Limited operations have been conducted by Atmospheric Sciences Laboratory at White Sands Missile Range (WSMR) and National Aeronautics & Space Administration (NASA) Wallops Island, Virginia and it was felt necessary to investigate the problems associated with utilizing personnel unfamiliar with the system.

The 5-inch gun was to be emplaced on the line of fire of the 16-inch gun and just forward of the service ramp. This would automatically keep the operation within the established safety limits and would keep the radar acquisition problems at a minimum. The complete layout of the installation with instrumentation and gun location, is shown in Figure 1.

The 16-inch system had an ample supply of hydraulic power which could be used to service the loading and elevating system of the 5 inch. The firing circuits of both systems would be integrated through the same panel.

After emplacement of the launching system, a training phase would be accomplished. This phase would use twelve projectiles with radar reflective payloads. All supervision is to be done by BRL personnel with the gradual transfer of duties to resident personnel as the firing progressed. This phase was to include the assembly of flight hardware, charge assembly, gun operation, event track and evaluation of data processing for forwarding to BRL.

An operational phase would be conducted entirely by the resident staff. A radar reflective payload was to be released at 200,000 feet every Monday and Tuesday, at 12:00 noon local time. All successful payloads were to be tracked down to an altitude of 70,000 feet. This phase would reveal any minor operational problems and sharpen the training until firings could be carried out on a precise schedule with a high reliability. Sufficient hardware was provided for an eight week schedule.

Special firing assignments were scheduled during the 16-inch series. This would include telemetry payloads to permit the simultaneous temperature and wind measurements. The installation and initial operation of the telemetry ground station would be performed by the Harry Diamond Laboratory and BRL personnel. This operation would also be turned over to the resident staff.

The resultant data from all phases would be routinely forwarded through BRL to Texas Western College for data reduction and inclusion in the monthly Meteorological Rocket Network Firings, Data Report.

INSTRUMENTATION

The Barbados gun is located at Longitude N 13° 4' 28" and Latitude W 59° 28' 37" with the gun trunnions 50 feet above sea level. The line of fire is 118° 44' with the Atlantic Ocean as an impact area.

A Fastax camera is located on the service ramp of the 16-inch gun. This camera photographs the model 75 feet in front of the muzzle.

The available radar consists of an M33 and an MPS19 unit. The M33 is 2,037 feet behind the 16-inch gun and the MPS19 is 1,690 feet behind the 16-inch gun. The M33 radar would be used for surveillance and event track and the MPS19 for vehicle track on the up-leg and event track. All range safety aspects with aircraft and ship traffic monitoring would be carried out in the same manner as for the 16-inch firing series.

The gun is drilled to accept muzzle probes and the muzzle velocity can be measured if desired.

Seawell Airport conducts a Rawinsonde wind run at 1200 hours daily. This data is available and will be used in the wind analysis.

There is a [illegible]50 meg cycle telemetry receiving station at launch control.

GUN INSTALLATION

The gun and associated equipment were sent to Barbados via the Air Force Eastern Test Range supply ship, "Gulf Stream", arriving 23 December 1965. BRL personnel arrived 11 January 1966 and emplacement and power connections were completed in time for an initial firing on 17 January. The coral rock formed a solid foundation for the gun (so solid that dynamite had to be used to emplace the mount trails.) The gun in position, on a metal ramp (to permit elevation to 90 degrees) is shown in Figure 2. Figure 3 shows the gun being fired. The survey pier used for aligning the 16-inch gun is just ahead of the 5-inch position and can also serve as a service tower for the 5-inch gun.

Firings were carried out 17 and 18 January utilizing half wavelength "S" band 5 mil copper chaff, for the first four shots. This chaff gave the M19 radar the maximum opportunity to acquire initially. For the next eight shots a six-foot square reflective parachute, with a 10-ounce weight, was employed. In general, the firings were successful with no major problem areas arising except that anticipated with the nose unlocking fuze.* The M19 radar was able to skin track the vehicle (Figure 4) to about 180,000 feet (not far from that expected for an M19) and then to proceed to the point of anticipated package deployment. This led to acquisition of the payload without any involved searching technique and finally reaching a point of acquisition within 10 seconds of the predicted time. Admittedly, there was an education process in the early part of the parachute deployment tests. Some time was spent tracking the ejected nose or chute canister before it was properly identified. The M33 radar was not able to track the vehicle and did not acquire any payloads on its own. However, when vectored in by the M19, the M33 was able to maintain track of the parachute target. Tracks of several of the rounds are given in Figures 5 thru 9. These plots give the height and azimuth as a function on range. It is noted that the parachute remains in the air about three

The 100 percent reliable modified MK80 delay fuze was in short supply at the time of this firing series and a less reliable fuze had to be substituted.

hours and could form a very minor aircraft hazard. In one case the chute impacted at sea about a mile from the launch point and was under visual observation (Figure 6).

It might be noted that on the last three firing days the rounds were fired within seven minutes of noon, two minutes of noon, and at noon. The deviations from noon were caused by the commercial air traffic, but this does show the capability of operation on a precise desired schedule.

After these initial 12 shots, the complete operation was turned over to the HARP Staff. To date 30 rounds have been fired with 20 wind tracks being obtained. There was one on-board telemetry payload with no wind tracking capability. The ejection system did not function on seven rounds and two rounds failed during launch*. Firing details for all rounds are given in the Firing Data Table.

During the February 1966 ionospheric wind measuring series for the 16-inch gun, simultaneous firings of the 5-inch wind sensor were planned and five such dual firings including two test pairs were made with the 5-inch gun firing two minutes after the 16-inch gun. The two minute delay was to allow the radar to track the up-leg of the 16-inch shot and prepare for the 5-inch shot.

FUTURE PLANS

With the satisfactory completion of the present phases, it is planned to start a program partially supported by ASL, WSMR and coordinated with ASL data acquisition at other sites. Although the firing program is not completely firm, it is expected to take one of two forms and to encompass at least one year.

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* *These two round failures are tentatively attributed to improper loading of the model in the tube.*

1. A twelve-noon firing every day.

2. A twelve-noon firing three days a week.

In either case, a mixture of simple wind measuring payloads combined with a wind and temperature measuring payload would probably be used.

EUGENE D. BOYER

FIRING DATA TABLE

Round	Date 1966	Firing Time Local	Payload	Vehicle Altitude K. Ft.	Payload Acquisition Altitude K. Ft.	Charge Lbs.	Pressure psix10^{-3}
	Jan.						
1	17	1621	Chaff	220	No Ejection	35	56.2
2	18	1071	Chaff	228	217	35	57.4
3	18	1521	Chaff	225	210	35	62.5
4	18	1607	Chaff	221	No Ejection	35	59.0
5	19	1100	Chute	220	155	34.5	62.2
6	19	1445	Chute	215	184	34	53.6
7	19	1557	Chute	215	No Ejection	34	54.9
8	20	1207	Chute	200	158	34	52.1
9	20	1525	Chute	238	212	34.5	63.0
10	21	1202	Chute	215	No Ejection	34	52.7
11	21	1550	Chute	210	192	34	52.7
12	24	1200	Chute	201	200	34	53.5
13	26	1210	Chute	210	No Ejection	34	54.9
14	28	1200	Chute	210	204	34	53.8
15	31	1240	Chute	219	209	34	53.8
	Feb.						
16	2	1335	Chute	196	196	34	53.4
17	7	1200	Chute	187	186	34	52.9
18	9	1203	Chute	210	No Ejection	34	51.7
19	11	1200	Chute	200	200	34	52.7
20	16	1300	Chute	200	198	34	51.9
21	17	1336*	TM	190	On Board	34	50.3
22	18	1101	TM/Chute	200	No Ejection	34	54.2
23	20	1753	TM/Chute	176	176	33.5	50.5
24	23	1838*	TM/Chute	200	197	34	49.3
25	23	2323*	TM/Chute	215	212	34	55.5
26	24	0216*	TM/Chute	185	175	34	48.7
27	25	1206*	TM/Chute	185	179	32.5	48.2

*These rounds were fired 2 minutes after a firing of the 16-inch gun.

FIRING DATA TABLE (Cont'd)

Round	Date 1966	Firing Time Local	Payload	Vehicle Altitude K. Ft.	Payload Acquistion Altitude K. Ft.	Charge Lbs.	Pressure psix10^{-3}
28	Mar. 1	1230	Chute	Model Failed		33.5	47.2
29	3	1200	Chute	Model Failed		33.5	48.7
30	4	1208	Chute	193	188	34.5	51.5

Sabot Wt = 5.0 Lbs.

Launch Angle = 85°. - Except for Rd 8 which was at 80°.

Tube No. 5375 - Diameter = 5.102

Chaff - 5 Mil copper half wave length S band

Chute - 6-ft. square Aluminized silk.

Launch Wt = 25.5 Lbs. (Chaff Rds - 27 Lbs.)

HARP TEST SITE

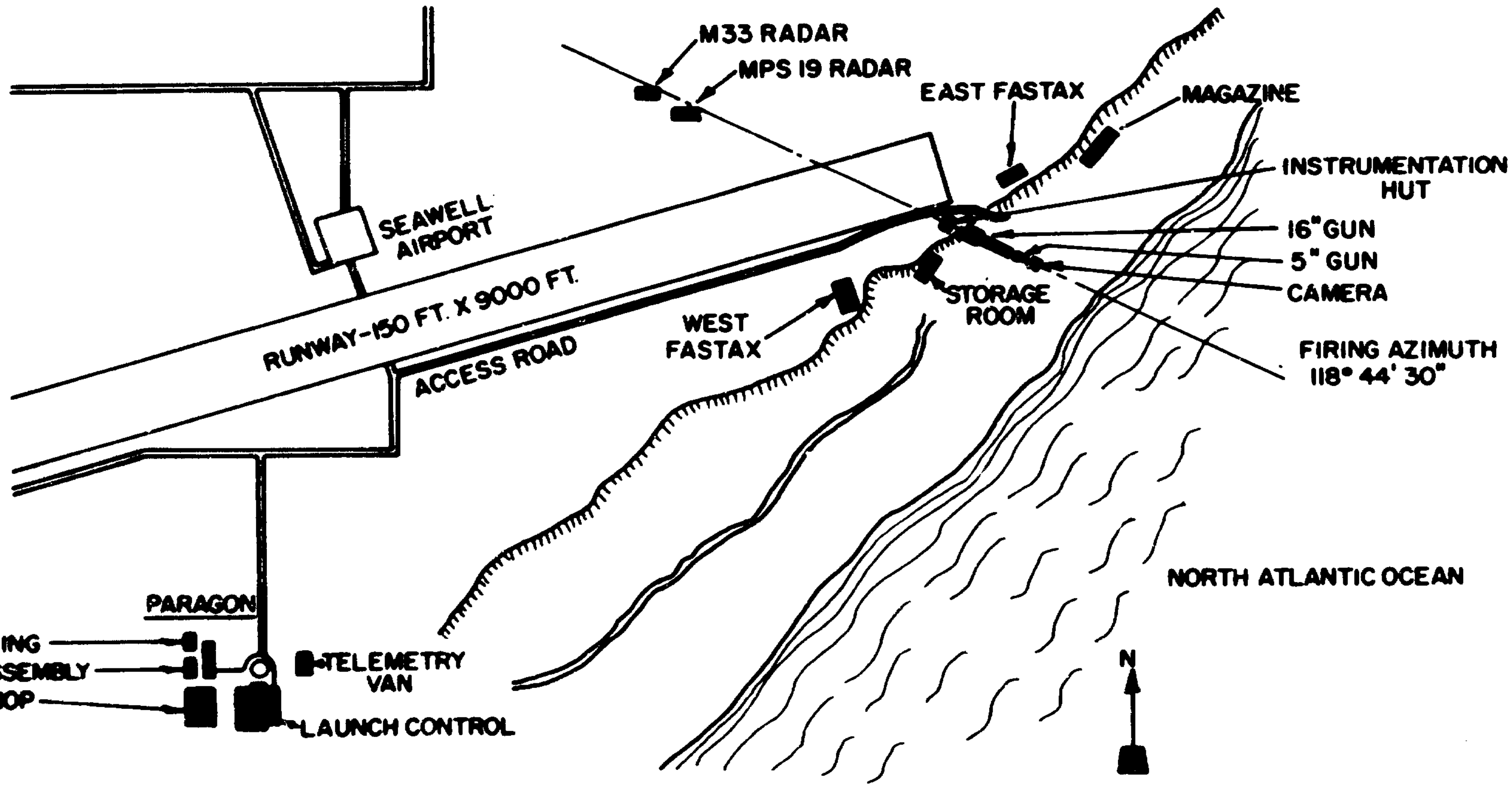


FIGURE 1

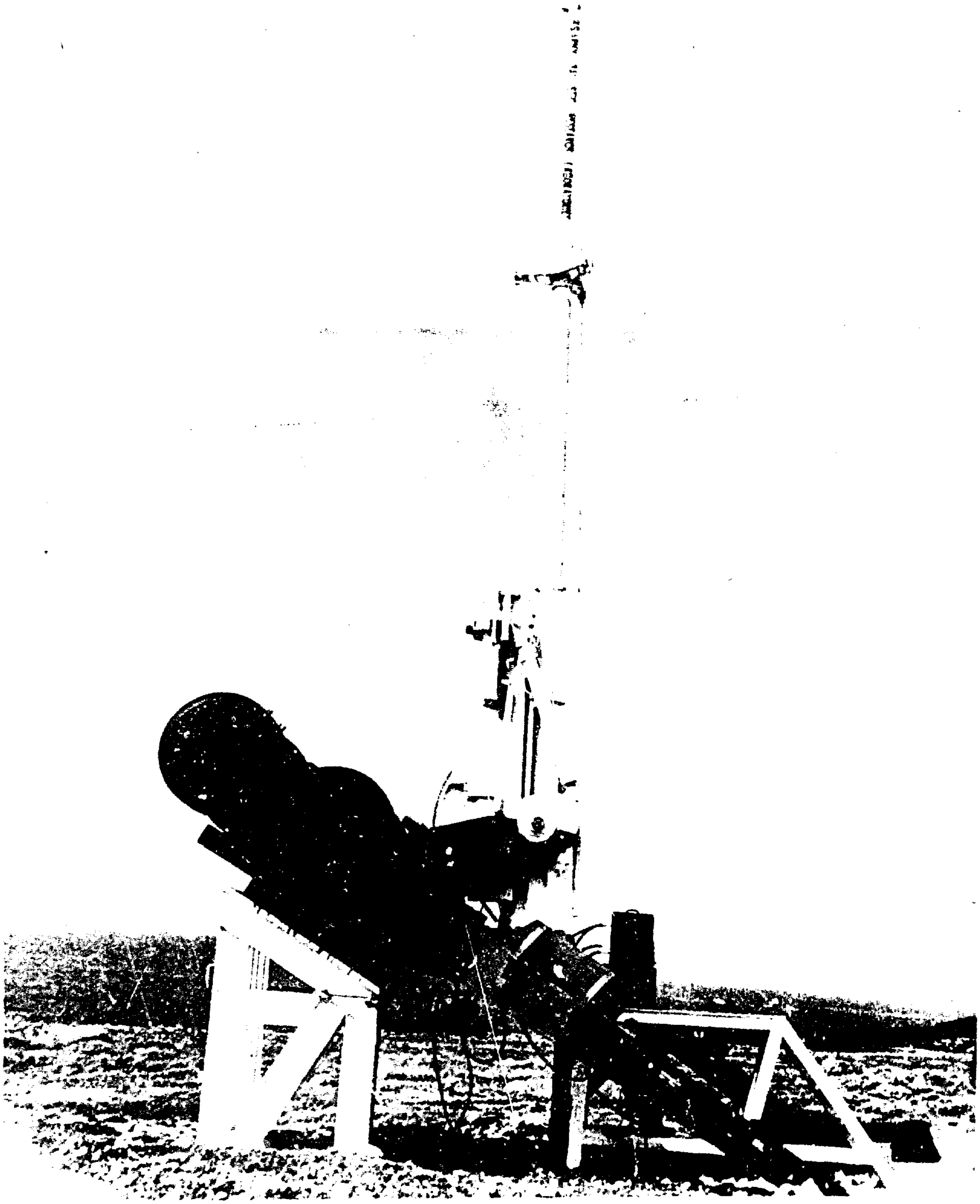


FIG. 2

FIG. 3

HARP 5-1 PROBE PROJECTILE

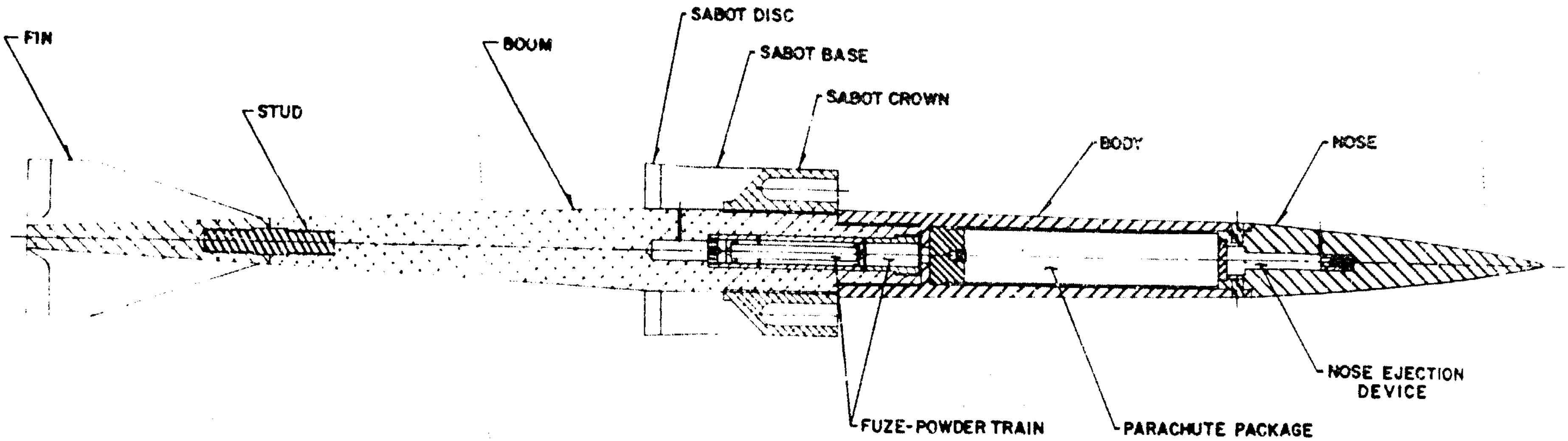


FIG. 4

M33 RADAR PLOT OF PARACHUTE DESCENT
20 JAN. '66
T₀=12:07 A.S.T.

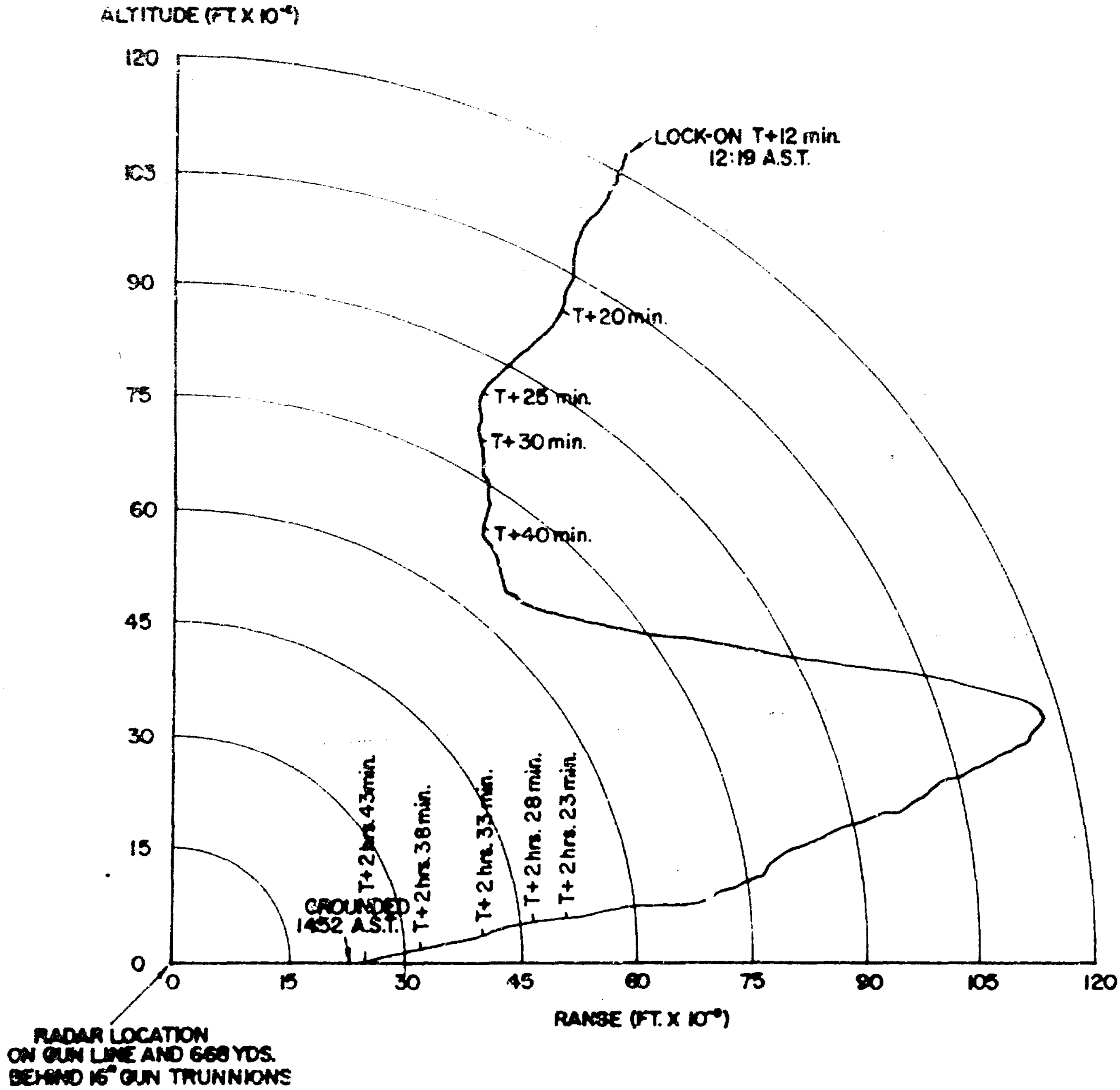


FIG. 5

M33 RADAR PLOT OF PARACHUTE DESCENT - T_0 = 12:07 A.S.T.
20 JAN. '66

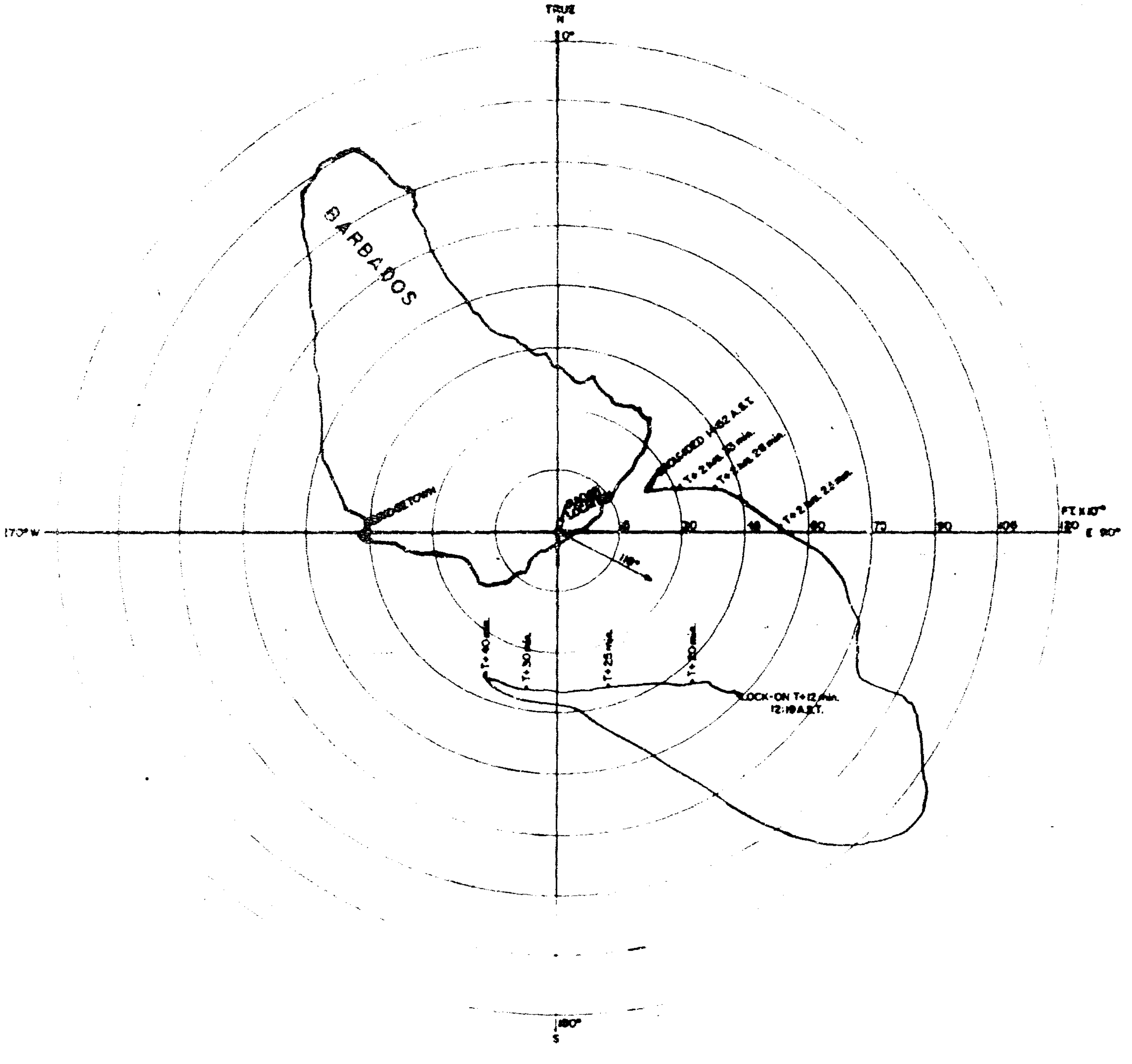
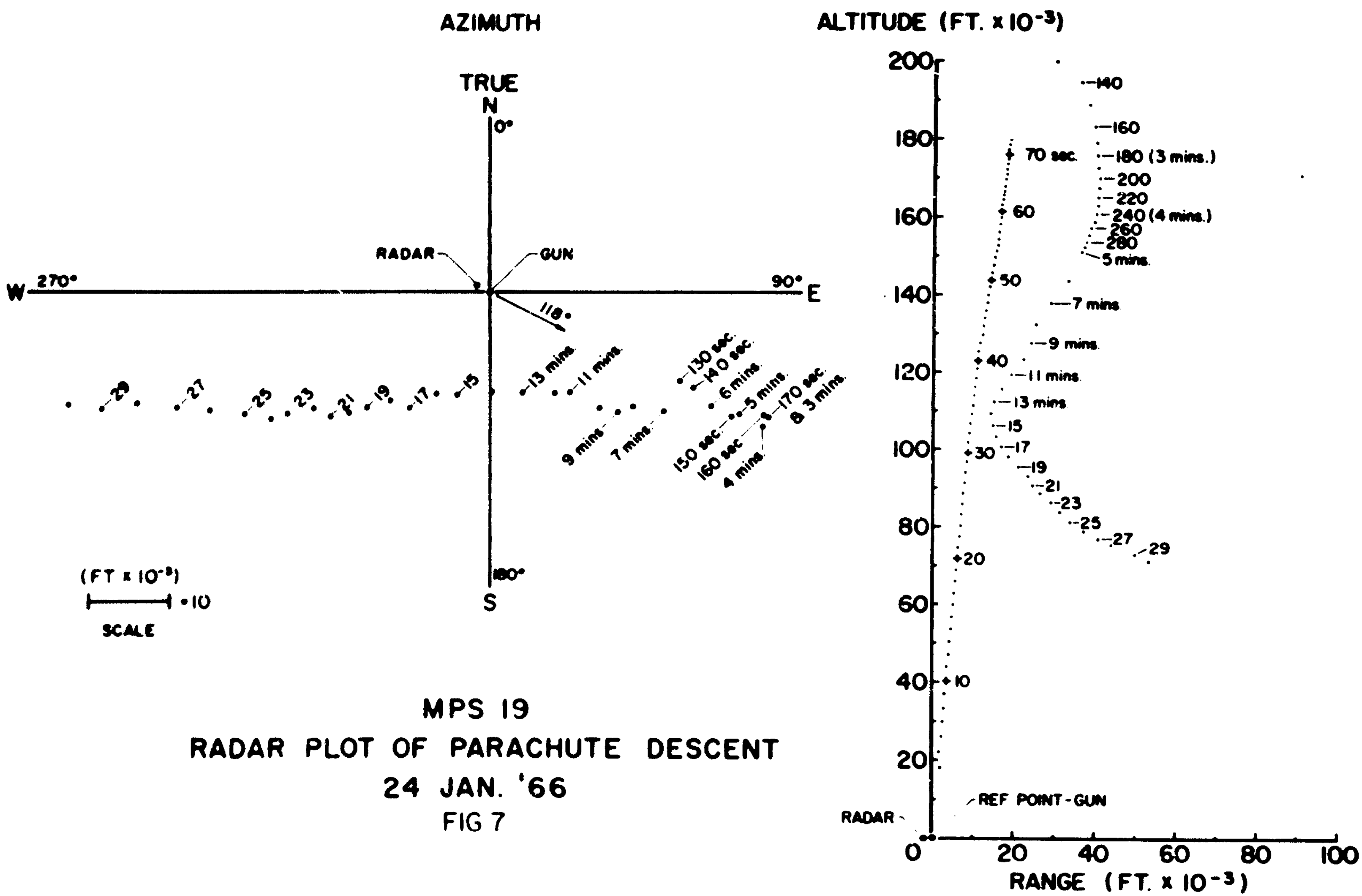


FIG. 6



MPS 19
RADAR PLOT OF PARACHUTE DESCENT
24 JAN. '66
FIG 7

M33 RADAR PLOT OF PARACHUTE DESCENT
24 JAN.'66

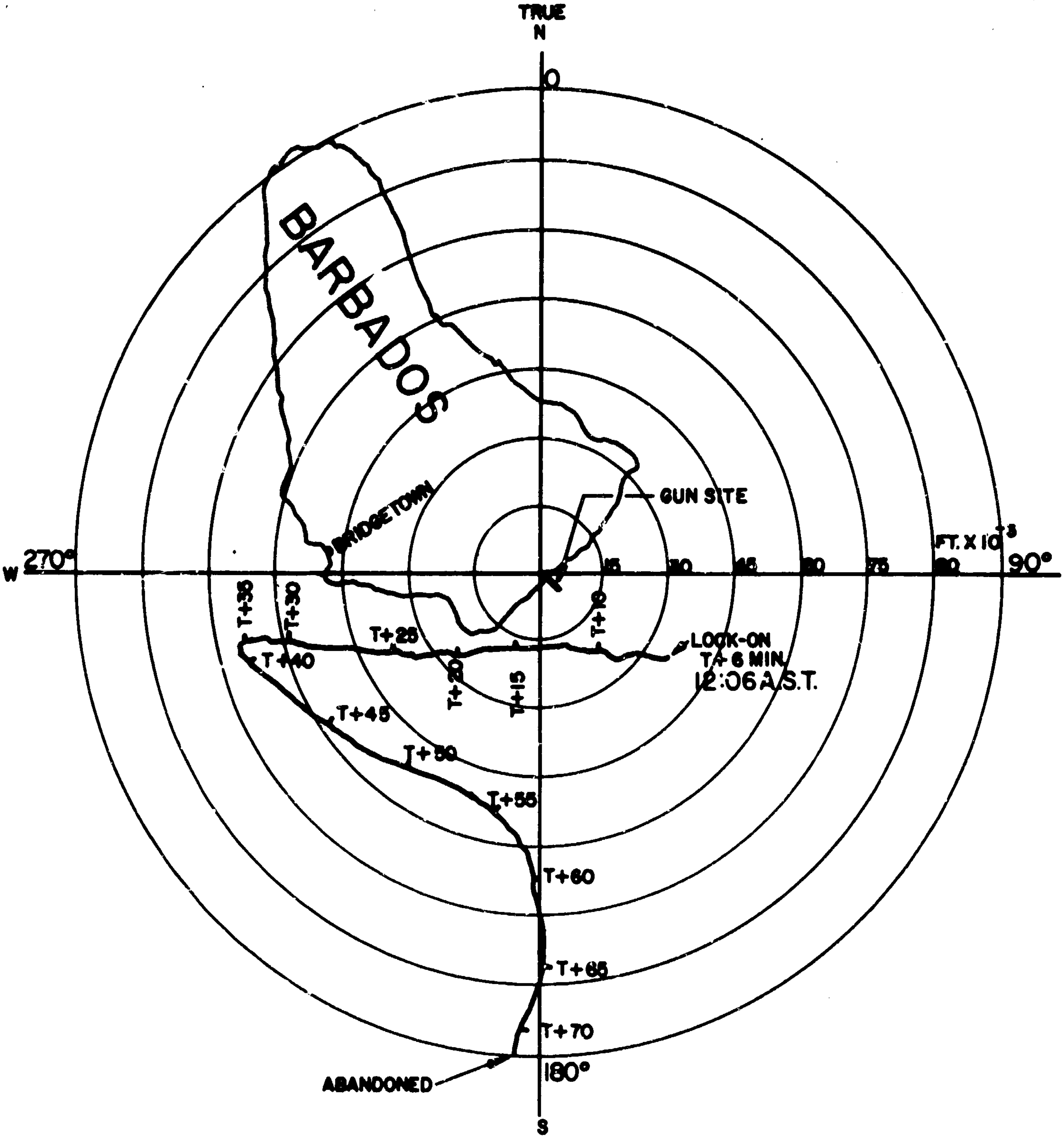


FIG. 8

M33 RADAR PLOT OF PARACHUTE DESCENT
24 JAN. '66

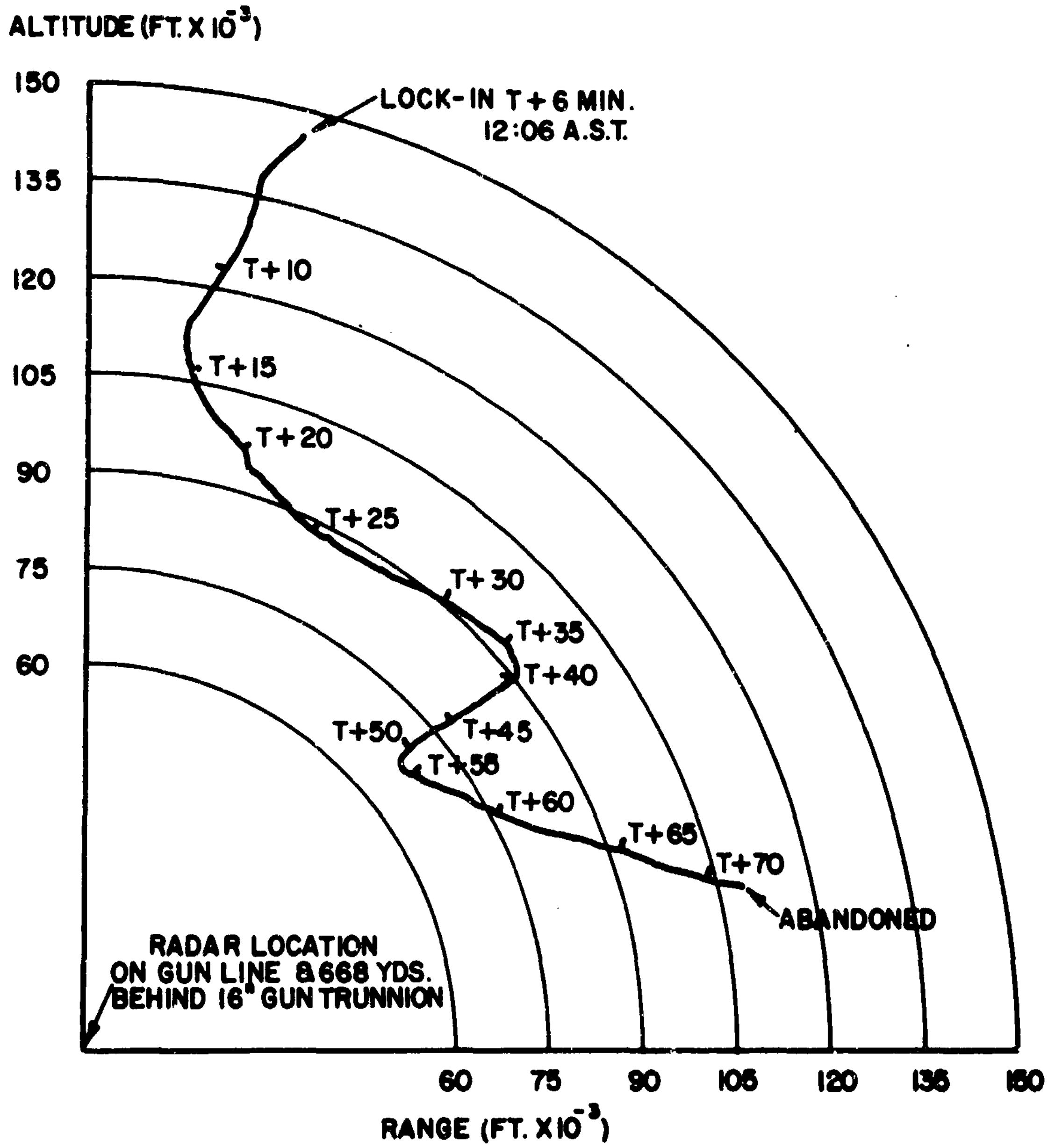


FIG. 9

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Unclassified

Security Classification

DOCUMENT CONTROL DATA - R&D	
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)	
1. ORIGINATING ACTIVITY (Corporate author) U.S. Army Ballistic Research Laboratories Aberdeen Proving Ground, Maryland	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP
3. REPORT TITLE FIVE-INCH HARP TESTS AT BARBADOS, WEST INDIES, JANUARY-FEBRUARY 1966	
4. DESCRIPTIVE NOTES (Type of report and inclusive dates)	
5. AUTHOR(S) (Last name, first name, initial) Boyer, Eugene D.	

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
July 1966	37	5

8a. CONTRACT OR GRANT NO. b. PROJECT NO. RDT&E 1A011001B021 c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) Memorandum Report No. 1771 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
10. AVAILABILITY/LIMITATION NOTICES Distribution of this document is unlimited.	
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY U.S. Army Materiel Command Washington, D.C.

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DD FORM 1 JAN 64 1473

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14. KEY WORDS	LINK A		LINK B		LINK C	
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